REPRODUCTIVE CYCLE OF *ACERENTOMON NEMORALE* WOMERSLEY (HEXAPODA: PROTURA) FROM SOIL IN DECIDUOUS WOODLAND

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Introduction

THE PROTURA, first described by Silvestri (1907) were, until relatively recently, classified as apterygote insects (Hennig, 1969) but are now considered to have class status (Manton, 1970). Their taxonomy has been worked upon by Gisin (1960), Tuxen (1964) and Nosek (1973). Worldwide there are 500 recorded species (Romoser & Stoffolana, 1994) divided into three families, Eosentomidae, Protentomidae and Acerentomidae. Protura occur in the soil where there is sufficient moisture present to permit plant growth and where decaying organic matter occurs (Berlese, 1909; Strenzke, 1942; Nosek, 1975). They are frequently present in considerable numbers in forest habitats, rich in humus (Nosek, 1975) but are less abundant in grassland and agricultural soils (Salt, Hollick, Raw & Brian, 1948; Raw, 1956; Lagerlöf & Andrén, 1991).

Little work has been done on the reproductive biology of proturans but Tuxen (1949) working in Denmark on *Acerentulus danicus* and *Eosentomon armatum* showed that both have five pre-adult stages; a prelarva, two larval forms, a maturus junior and a preimago. *A. danicus,* a surface dweller is markedly univoltine reaching maximum density during the summer, the juvenile stages succeeding each other in regular sequence from May to September and only adults present during the winter. The sex ratio during the summer is weighted heavily towards the females but is more even in the winter. In contrast Tuxen (1949) showed that all stages of *E. armatum* are present throughout the year and the sex ratios very even.

Although records of British proturans were published by Bagnall (1912, 1934, 1936), Brown (1917) and Womersley (1924, 1927, 1928), no work has been done on their life cycles. It was thus considered of use to examine the life cycle of *Acerentomon nemorale* Wom., a species present in woodland soils.

Materials and methods

Soil cores, measuring 5.2cm diameter and 13.5cm long were taken in mixed deciduous woodland at Clyne, Swansea, South Wales, SS 911612 throughout the year. Franz, Haybach and Nosek (1969) showed that the majority of proturans occur in the top 10cm of the soil. To extract the proturans the soil cores were placed in a Berlese/Tulgren funnel for eight days. Specimens were collected in tubes containing 70% alcohol and any proturans present, removed. These were then cleared in Essig's aphid solution (Nosek, 1973) to facilitate identification of species and developmental stages.

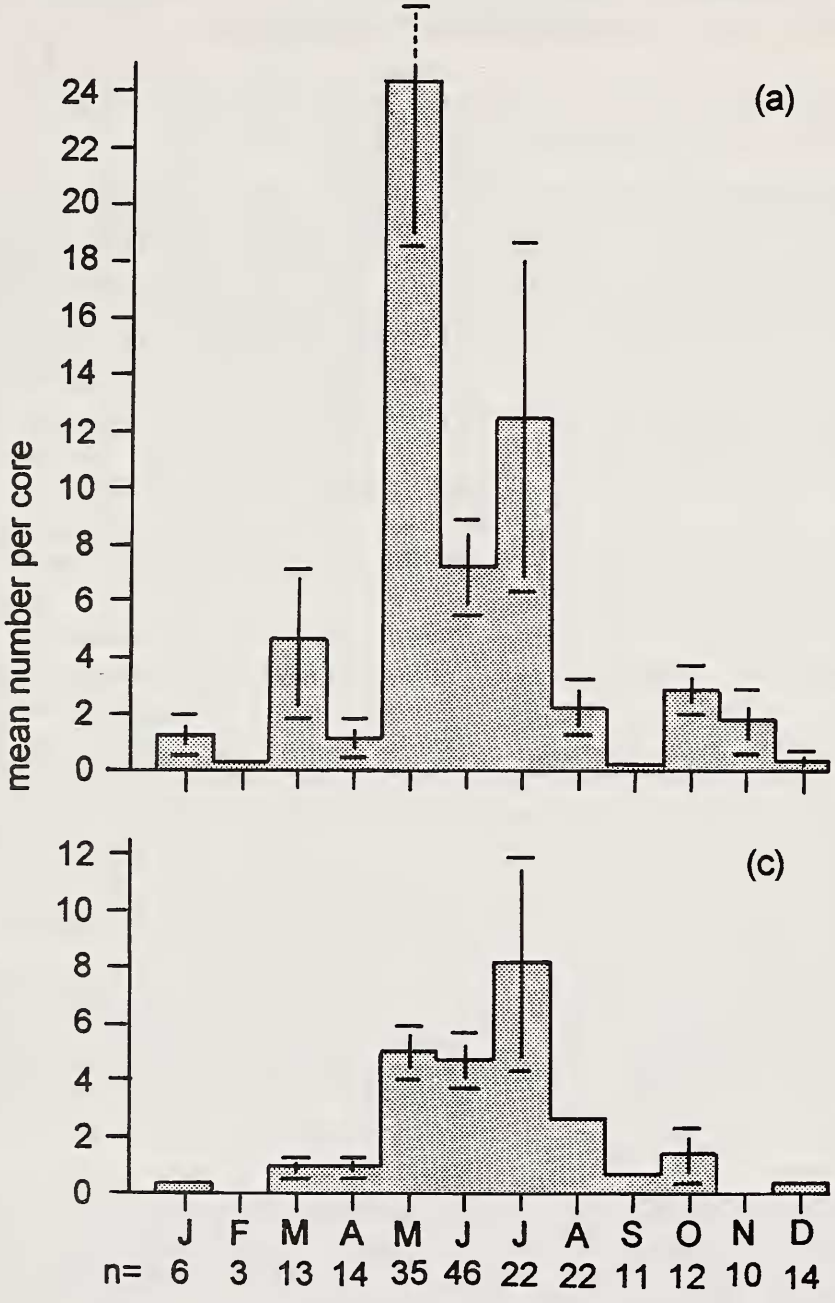
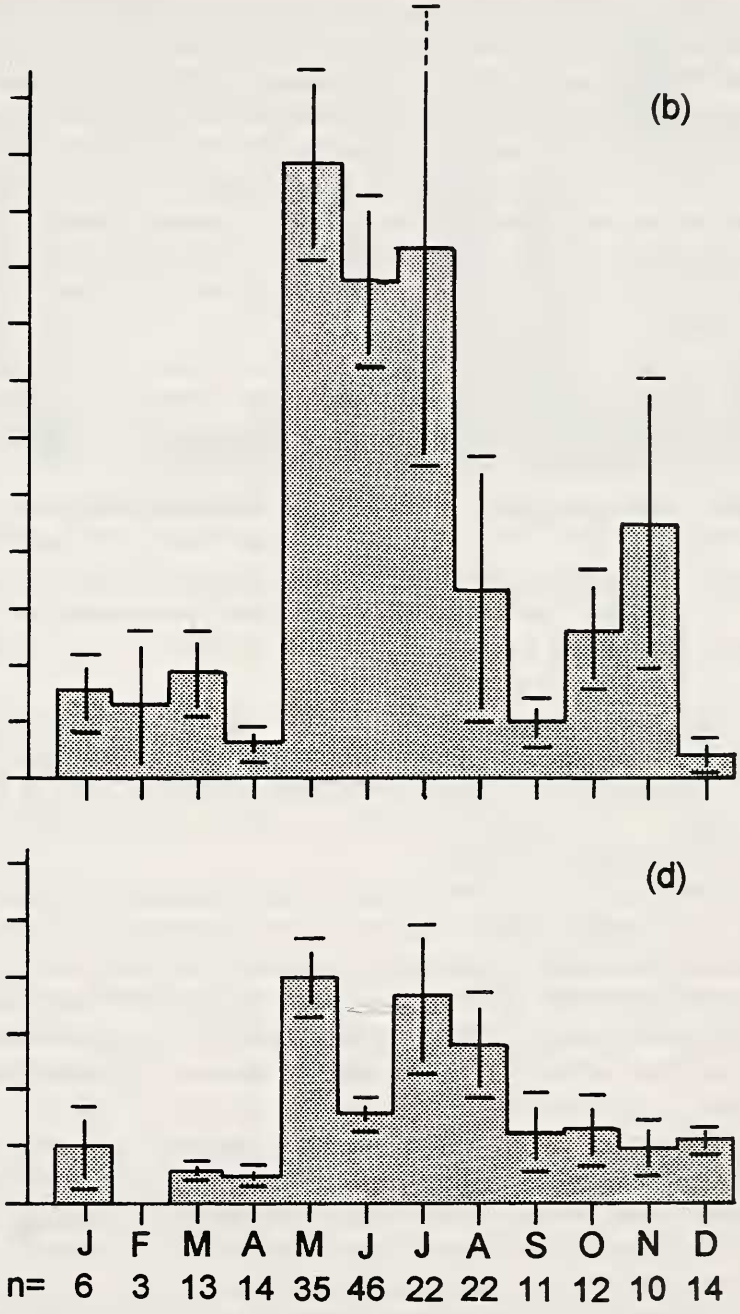


Figure 1.
Monthly means (±S.E.) of the development stages of *Acerentomon nemorale* from mixed woodland.
(a) Larvae 1; (b) larvae 2; (c) maturus juniors; (d) adults (including preimago males).
n = number of cores taken.



Results

Adult proturans are minute elongate, whitish, and have entognathous mouthparts, no eyes, ocelli or antennae, though "pseudoculi" may represent vestigial antennae. Legs have 1-segmented tarsi and a single claw. The abdomen has short, bilateral styli or abdominal appendages on the first three segments. Development is ametabolous and anamorphosis occurs. This is unique in hexopods but occurs in other arthopods.

The number of abdominal segments increases from nine in the early larvae to 12 in adults. The characters used to determine the species were, the structure of abdominal styli on abdominal segments I, II and III, the chaetotaxy of terga VII and sterna VIII and the size, shape and arrangement of the sensillae on the fore tarsi (Nosek, 1973; Tuxen, 1964). *Acerentulus confinis* Berl. and *Acerentoman affine* Bagn. adults were also recorded in the soil cores but in much lower numbers (King & Aazem, in prep.). The LI and LII of *Acerentulus* sp. are quite distinct from *Acerentomon* spp. larvae and have been described in some detail by Tuxen (1964) and Nosek (1973). The LI and LII of *A. affine* and *A. nemorale* are very similar but can be distinguished by the size, shape and arrangement of their fore tarsal sensillae. As *A. nemorale* was the predominant species it may be assumed that the larval stages of *Acerentomon* spp. belonged to *A. nemorale*.

Nosek (1973) described the five stages of development:

THE PRAELARVA, presumed to be the first stage although hatching from the egg has not yet been observed. It has nine abdominal segments, the mouthparts are not fully developed and do not reach beyond the anterior border of the head. The fore tarsi and abdominal appendages are less well developed. This stage was not observed in the present study presumably because of the difficulty in extracting them.

THE FIRST LARVA (L1) in which the mouthparts, legs and abdominal appendages are fully developed and there are nine abdominal segments. These were present during every month but showed a peak in May with slightly fewer in June and July. There was a second small increase in October and November (Fig. 1a).

THE SECOND LARVA (L2), which has ten abdominal segments and different sclerotization, chaetotaxy and sensillae. These were also present throughout the year in larger numbers than larva 1 which suggests that this stage may be of longer duration than that of larva 1. Numbers peak in May and remain high during June and July. After a fall in September they increase briefly in October and November, coinciding with the increase in numbers of larva 1 (Fig. 1b).

MATURUS JUNIOR has 12 segments like the later stages but lacks genitalia, has less sclerotization and different chaetotaxy. These peak during May, June and July but are missing during some months. This stage is not as abundant as larvae 1 and 2 which suggests either that it is a very short stage or there is considerable mortality when moulting from larva 2 (Fig. 1c).

THE PREIMAGO males differ from earlier stages in possessing genitalia, chaetotaxy and sclerotization. These are present from May to August in reasonable numbers with a few in October, November and December but were not present during the other months. This suggests that males only reach maturity during those months (Fig. 1d). Some adults are present during most months but there was a marked increase in favour of the females between May to September (Fig. 2) which coincides with the breeding season.

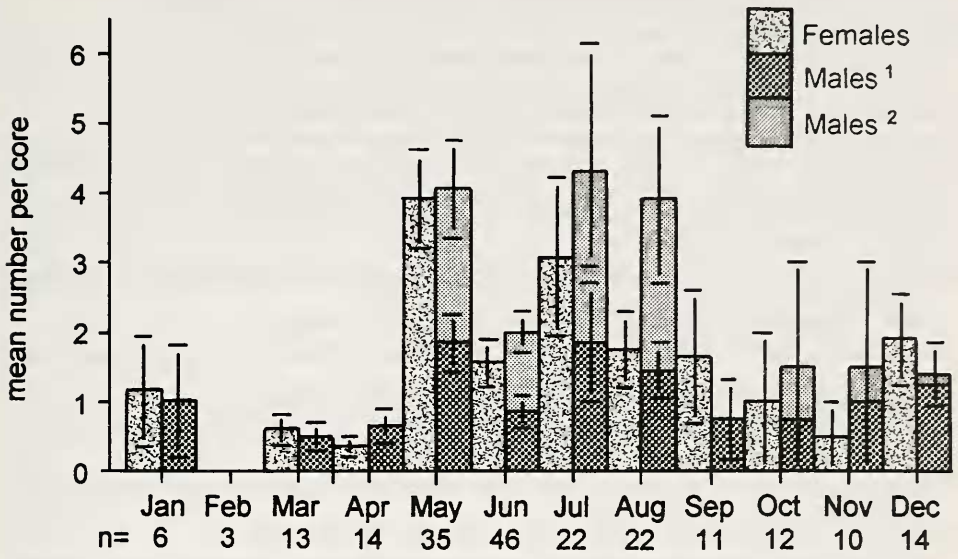


Figure 2. *acerentomon nemorale* monthly sex ratios (±S.E.).
Males[1] = excluding preimago males; Males[2] = including preimago males.
n = number of cores taken.

Discussion

Comparing the present findings with those of Tuxen (1949) *A. nemorale* shows evidence of a main summer breeding period in common with *A. danicus,* together with a summer sex ratio weighted in favour of the females and an overall reduction in adult numbers suggesting a high mortality. It also compares with *E. armatum* in having juveniles present throughout the year. Wallwork (1970) suggested that perhaps *E. armatum* migrates to a depth of 5cm in the soil profile. Thus, the juvenile stages are protected during the winter, whereas juveniles of *A. danicus* are not. In the present study, cores were taken to a depth of 13.5cm which included the entire humus layer, so that possible migrations could be allowed for. In contrast to Tuxen (1949) larva 2 was the most abundant stage during the winter months. Larva 1 and Maturus junior stages are probably of much shorter duration than the others and there is a marked post-reproductive mortality amongst the adults. The results can possibly be explained by less severe winters in the present habit.

Acknowledgements

We would like to thank Alison Smith for the collection of the original samples.

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Scarce Large Blue butterfly, *Maculinea telejus* Bergstr. (Lep.: Lycaenidae), in Slovenia

Slovenia seems to be on the edge of or possibly outside the range of *Maculinea telejus,* according to distribution maps in the European field guides. However, I was lucky enough to find a few specimens on 26th July at Ljubljansko Barje. This is a former peat bog, now extensively drained for agriculture, just outside the capital city, Ljubljana.

Since finding this species and *M. nausithous* Bergstr. in Austria in 1992 (*Ent. Rec.* **105**: 143-146), I have been looking out for grassland dominated by their foodplant *Sanguisorba officinalis.* Although *Sanguisorba* was present at Ljubljansko Barje, it was much more plentiful in a larger area of damp, unimproved grassland at Planinsko Polje, some 25km south-west of Ljubljana. Some 50 hectares of meadows were dominated by *Sanguisorba,* but I could not find any Large Blues when I visited on 4th August.

It may be worth checking this area and nearby poljes at Cernicka and Postojna in mid-July.– David Withrington, English Nature, Northminster House, Peterborough PE1 1UA.